The collection from British North Borneo has many interesting exhibits, notably some remarkably fine specimens of gutta-percha and india-rubber a magnificent plank of the Sumatra or Bornean camphor-tree (*Dryobalanops aromatica*), thé crystallised camphor of which is found deposited in cracks and fissures in the wood, occurring sometimes in very large masses; it is largely used by the Chinese, who prefer it to the ordinary camphor of commerce which is produced in their own country. Bornean tobacco is also a prominent object here, and is exhibited both in bundles of cured leaves as well as in cut form. A favourable report has been obtained of this tobacco, and it has been valued above the average of Sumatra tobacco, for which indeed it has been mistaken even by experts.

In the Hong Kong Court the varied uses to which bamboos and rattans are put are largely represented; the difference, however, in the character of the work to which the stems of these two classes of plants are applied is manifest at a glance, for while the rigid stems of the *Bambusas* are used for the rougher or coarser work, those of the pliable species of *Calamus* form the materials from which the finer basket-work, screens, &c., are manipulated. Various examples of the baker's art in the form of biscuits are shown by the Hong Kong and China Bakery Company, Limited, and it is stated, as an illustration of the capabilities of this bakery, that it can turn out 15,000 pounds of ship biscuits or 10,000 pounds of bread per day.

The British Guiana collection almost adjoins that of Hong Kong. Here, as might be expected from the extent of the forests of the colony and the abundance of large hard-wooded trees, timber takes a prominent place, and some magnificent specimens of the best known woods, such as mora (*Dimorphandra Mora*), greenheart (*Nectandra Rodiœi*), wallaba (*Eperua falcata*), and other well-known and useful timbers are exhibited. The heartwood of these timbers is described as "almost everlasting, the beams of old houses being good for over a hundred years in the most unfavourable circumstances of a tropical climate infested with wood-ants and other vermin." Specimens of tibiserie fibre and hammocks made from it are here exhibited. This fibre, which is obtained from the young leaves of the Eta palm (*Mauritia flexuosa*), is of wonderful strength and tenacity, from it the natives make their strongest and most durable cords and hammocks. It is very easily obtained and in any quantity, and if better known in Europe might become a valuable article of commerce. A fine collection of medicinal and tanning barks are here shown, but unfortunately, like the woods from this colony, comparatively few have other than native names. In the catalogue of exhibits it is stated that "the medicinal barks are very varied; a few are well known, but the majority, having never received the attention of chemists or physicians, are as yet untried, but may possibly be found worthy a place in the Materia Medica. Fair quantities are exhibited, and will be distributed to qualified persons who will undertake to report on their qualities. Most of them are common in the colony, and can be easily procured."

It is scarcely correct to say that the medicinal barks of British Guiana have never received the attention of chemists or physicians, for at the close of the International Exhibition of 1862 some twenty different medicinal barks of the colony were experimented upon and their effects tried in various cases by Mr. Charles Hunter, who was some time House Surgeon to St. George's Hospital. The results of his experiments were embodied in a pamphlet, and published at the time by Messrs. Churchill and Sons of New Burlington Street, but we never heard that any of them came into use in this country, and it is to be hoped that better results may be obtained from the present collections.

JOHN R. JACKSON

WHAT IS A GLACIER? [1]

GLACIERS have become so well known from the graphic descriptions of Carpenter, Forbes, Agassiz, Tyndall, and other explorers, that it seems unnecessary at this time to do more than call attention to a few of their more characteristic features by way of an introduction to what I have written concerning those now existing in the United States.

The formation of glaciers in any region depends primarily on the fact that the amount of snow precipitated during a term of years exceeds the amount dissipated by melting and evaporation. In this manner snow-banks of broad extent are formed, the lower portions of which become compacted into ice. The change from snow to ice is known to result from pressure, and as ice is mobile under pressure, either by reason of its inherent plasticity or as a result of regelation, the weight of this mass tends to change its form, and it thus acquires motion, which takes the direction of least resistance.

The essential characteristic of glaciers seems to be that they result from the consolidation of snow in regions of secular accumulation, *i.e.* above the snow-line, and flow to regions of dissipation, *i.e.* below the snow-line. From these primary conditions result a multitude of secondary phenomena.

For convenience of reference we will divide glaciers into *alpine* and *continental*; not that the two classes are always distinct and separable, but for the reason that typical examples of each are well characterised and capable of specific description. Variations occur in each class which may suggest minor subdivisions.

The glaciers with which we are most familiar belong to the class that have their archetype in the mountains of Switzerland, and occur about high peaks, usually in amphitheatres or *cirques* at the heads of high-grade valleys. The snow that accumulates on high mountains, especially in temperate latitudes, is frequently not completely melted during the summer, and thus tends to increase indefinitely. The *névé* of a glacier is such a snow-field. The gorge or valley leading from every alpine amphitheatre furnishes an avenue of escape for the consolidated *névé*-snow, which is forced out through the opening, and flows for a greater or less distance as a stream of ice. Such in brief is the genesis of an alpine glacier. Every glacier of this class is divided into a *névé*, or snow-region, above, and an icy portion below. The line of demarcation is the *snow-line*. As compact ice occurs also beneath the *névé* from which it is formed, this division of a glacier into two portions applies only to the surface. The division line, moreover, shifts with the seasons; at times, perhaps for many years together, the true glacier ice may be concealed by a snowy covering. The *névé* is composed of granular snow, white or grayish-white in colour, and comparatively free from dirt and stones; below the snow-line the glacier is formed of both porous and compact ice, and is usually concealed more or less completely with rock-debris. From a distance these two divisions are frequently distinctly shown by contrast in colour. The stones and dirt that fall on the *névé* sink more or less deeply into the snow and become buried beneath the next addition, and as the *névé* becomes consolidated and acquires glacial motion, this debris is carried along in its mass. But the region below the *névé* being one in which loss exceeds supply, the snow and ice are melted, and the foreign bodies formerly held in the mass become concentrated at the surface, and are then carried along as moraines. Thus in the *névé* region the tendency is to bury foreign objects, and in the glacier proper to concentrate them at the surface.

All the debris carried by glaciers may be designated in general terms as *morainal* material, but when arranged

[1] From Memoir on "Existing Glaciers of the United States," by Israel C. Russell. Reprinted from the Fifth Annual Report of the Director of the U.S. Geological Survey.

in definite ways it receives specific names. When distributed along the margin of an ice-stream it forms *lateral* moraines. Two glaciers uniting, the right lateral moraine of one combines with the left lateral moraine of the other to form a *medial* moraine at the line of contact, the ice-streams flowing on side by side as a single compound-glacier. The debris carried to the extremity of a glacier and deposited about its foot is known as a *terminal* or *frontal* moraine.

In flowing through a valley ice is subjected to stress, which causes it to fracture and form open fissures termed *crevasses*. When a glacier passes over a steep ascent it becomes broken by a great number of fissures, and not infrequently falls to the base of an escarpment in detached blocks, forming an ice cascade, but heals its scars and flows on as a solid mass below. The fissures formed when a glacier passes over an inequality in its bed are commonly transverse to the direction of flow, but may take other courses, depending on the nature of the obstruction, change of slope, &c. Marginal crevasses, resulting from the friction of the ice-stream against its banks and the consequent more rapid flow of the central portion, usually leave the shore at a moderate angle and tend up-stream.

Glacier ice has been found to exhibit a definite structure, known as lamination, or as ribboned or banded structure, produced by the alternation of thin plates or strata of compact bluish ice with others more porous. As shown by Tyndall's experiments, this arrangement is the result of pressure, and is analogous to slaty cleavage.

Owing to unequal melting, the surface of a glacier is usually extremely irregular, the parts protected by moraines standing in higher relief than the clearer portions. Still further diversity is formed by boulders perched on columns of ice, which they have protected from melting as the general surface wasted away. These are termed *glacial tables*. At other times the ice bristles with a multitude of acicular pyramids, or is melted into holes and ice-wells, each having a stone or mass of dirt at the bottom.

The melting of the surface of a glacier gives rise to many rivulets and brooks, which course over it in channels of ice, frequently plunging into yawning crevasses, and finally joining the sub-glacial stream that issues from beneath every glacier. These glacier-born streams are always heavy with comminuted rock, ground fine by the moving ice.

Such in brief are the principal characteristics of alpine glaciers.

At the present time continental glaciers are confined to the arctic and antarctic regions, and have been less thoroughly explored than the alpine forms common in more temperate latitudes. Glaciers of this class are characterised by their broad extent and by not being confined by definite walls; their *névés* are large, frequently covering nearly the entire glacier, and their surfaces are free from boulders and debris, for the reason that they are regions of accumulation, and also because mountains seldom rise above them. Owing to inequalities in the country over which these great fields pass, they are not infrequently broken by crevasses; and, as on smaller glaciers, the melting of the surface gives origin to numerous streams, frequently of large size, which become ponded and form lakes in basins of ice, or plunge into open fissures and disappear in the body of the glacier. Existing continental glaciers are believed in all cases to flow from the interior towards the coast, and hence may be considered as acquiring motion in all directions from a centre of accumulation. When alpine glaciers increase sufficiently to cover an entire mountain-range and form a confluent ice-sheet, they approach and may pass into the continental type. It is not impossible that a mountains range of very modest dimensions might give origin to a quaquaversal glacier of vast proportions. It is perhaps not out of place to suggest in this connection that the glaciers which formerly covered the New England State and Canada were of this character.

In framing a definition of a glacier it is evident that we must include both alpine and continental types, and also embrace the secondary phenomena that are commonly present. A glacier is an ice-body originating from the consolidation of snow in regions where the secular accumulation exceeds the dissipation by melting and evaporation, *i.e.* above the snow-line, and flowing to regions where loss exceeds supply, *i.e.* below the snow-line. Accompanying these primary conditions many secondary phenomena, dependent upon environment, as crevasses, moraines, lamination, dirt-bands, glacier-tables, ice-pyramids, &c., may or may not be present. Thus, glaciers even of large size may exist without moraines; in such an instance glacier-tables, ice-pyramids, ice-wells, &c., would be absent. We may conceive of a glacier flowing through a channel so even that it would not be broken by crevasses, but such instances must be extremely rare. The most common of the numerous secondary features seems to be the laminated structure of glacial ice, but even this is not always distinguishable in ice-bodies that are unquestionably true glaciers.

Although the definition we have presented may assist in understanding the nature of a glacier, yet it is manifestly open to objections. If we consider the snow-line as defining the limit between the *névé* and the glacier proper, it is evident that there must be numerous exceptions to the rule. As before remarked, during certain years, and in many instances for a term of years, the snow-line is much lower than at other times, and may completely conceal the glacier beneath. Again, an ice-stream may terminate in the sea and be broken up and form icebergs before the differentiation into *névé* and glacier proper has been reached.

From all that has been determined concerning the nature of glaciers it is evident that they form one of the transition stages in the history of the snow that falls in certain regions, and like genera and species in the organic kingdom cannot be limited by hard-and-fast lines, but may be classified by comparison with typical examples. From the snow, hail, and frozen mists of a mountain-top are formed the accumulations of granular ice-snow which we call a *névé*. By pressure and alternate melting and freezing, the *névé* passes into compact ice, which acquires motion and is termed a glacier; but the plane of separation is indefinite, and one merges into the other by insensible gradations.

The morainal material carried by glaciers is deposited when melting takes place, and frequently forms characteristic accumulations that still retain the name of moraines. The debris along the border of an ice-stream is frequently left as ridges or irregular terraces on the sides of a valley, marking the former height of the ice-flood. At various stages in the retreat of the ice the lateral moraines are united by terminal moraines which cross the former bed of the glacier in irregular but usually crescent-shaped piles, between which the valley bottom is usually deeply filled with unassorted debris, and frequently occupied by lakelets. When a glacier is prolonged from the mouth of a valley on a plain, it builds out its lateral moraines perhaps for many miles, and when it retreats these are left as parallel embankments, not infrequently hundreds of feet high and sometimes miles in extent.

The movement of glaciers causes friction, which results, as the study of living glaciers has shown, in the smoothing and scratching of the rocks over which the ice passes. The boulders, pebbles, and sand held in the bottom and sides of the glacier produce smooth and polished surfaces, crossed by scratches and grooves having an exceedingly characteristic appearance, which, when once understood, it is difficult to mistake for the results produced by other

agencies. While the rocks beneath a glacier are being worn and rounded, the stones set in the ice are in turn battered and scratched and often ground down to plane surfaces that are not infrequently polished and covered with glacial striæ.

As a rule, alpine glaciers follow pre-existing drainage valleys, which they enlarge and broaden. As frequently stated, a stream-cut gorge is distinctly V-shaped, but after being occupied by a glacier it is found to have become U-shaped in cross-section.

The records of glacial action looked for by geologists are: deposits of morainal material, which frequently differs from the adjacent country rock, and may occur in an irregular manner or be grouped definitely as lateral and terminal moraines; boulders perched in fortuitous positions, as on steep slopes and hill-tops; smoothly rounded rocky knolls; polished and scratched rock surfaces; rock-basins, &c.

NOTES

IT is stated that the forthcoming "Life and Letters of Charles Darwin," by Mr. Francis Darwin, will contain a brief autobiographical fragment.

MR. MURRAY announces a new edition of Darwin's work on "The Expression of the Emotions in Man and Animals," with the author's latest corrections.

WE learn from the *Times* that Dr. Hermann Abich, the distinguished Austrian naturalist, died at Vienna on the 1st inst. at the advanced age of eighty years. He was born at Berlin on December 11, 1806, and attained the grade of Doctor in the University of that city before he was twenty-five. His first scientific tours were in Sicily and Italy. He then became Professor of Mineralogy at Dorpat, and devoted most of his leisure during his residence in Russia to travels in the Caucasus, Armenia, and Northern Persia. His earliest published work was on Vesuvius and Etna in 1833–34, and his latest seems to have been brought out in 1862 on the Geology of Daghestan. By his own request his remains were removed to Gotha for the purpose of cremation.

WITH reference to the recent catastrophe by which the King of Bavaria and his physician lost their lives, *Science* notes that Dr. Gudden is a sad loss to science, for he was one of the most noted authorities in the sphere of nervous and mental diseases. He has also been at the head of a laboratory in which investigations of the fine anatomy of the brain, spinal cord, and sense-organs have been carried on. He has given his name to a manner of studying the connections of the nervous system which is as ingenious as it has proved fruitful of results. His method consists in extirpating a sense-organ or other part of an animal when young, and then allowing the animal to grow up. At death the animal is examined, and the fibres which have failed to develop will thus be marked out as the paths of connection between the extirpated sense-organ and the brain-centre. For many years he had been at work on the problem as to the mode of connection between the retina and the brain, but his results are not yet before the public.

ACCORDING to *Science* the first circular of the local committee at Buffalo of the American Association for the Advancement of Science, announces that the meetings will be held in the recently enlarged high-school building. Reduced rates have been obtained over many of the railroads, most of which allow a return ticket at one-third of the usual fare. The Western Union Telegraph Company will place its lines and district telegraph system at the service of members. The Botanical Club of Buffalo is arranging an excursion and reception for the Botanical Section, and the local Entomological Club is doing the same kind service for the Entomological Section. The address of the local secretary is Dr. Julius Pohlman, Buffalo, N.Y.

As our readers are aware, it has been resolved to mark the memorable event of the attainment, on August 31 next, of his hundreth year by the venerable father of modern science, "Le Doyen des Étudiants," as he loves to call himself—M. Chevreul—by striking a medal in his honour. The execution of this medal has been intrusted to M. Roty, old "pensioner" of the Academy of France, at Rome. Contributions towards the commemorative medal are, of course, not to be limited to France, but will embrace the whole scientific world, which everywhere alike claims the author who extended the bounds of science as its honoured citizen. Subscriptions, which will be received up to the 22nd of this month, may be addressed to the President of the Committee, 8, Rue Guy-de-la-Brosse, Paris. A list of the subscribers will accompany the medal, which is to be presented to M. Chevreul on his centenary day, and if the amount of the subscriptions allows of it, a copy of the medal will be sent to the subscribers.

AT the sitting, on June 7 last, of the Academy of Sciences at Paris, M. Halphen delivered an address in praise of the labours of M. Bouquet, his immediate predecessor in the seat he holds in that body. From the foundation of the Academy down to the present time, the duty of eulogising departed members has devolved exclusively on the Perpetual Secretaries at the anniversary meetings. The annual death-rate of members has, however, of late been such that a large number of them were in danger of disappearing from the roll without any formal record of their services. The initiative thus taken by M. Halphen was followed up at the next meeting. This step has, of course, been taken in imitation of the arrangements of the Académie Française, in accordance with which each incoming member is required to eulogise his predecessor at a special meeting, an answer being also given in the name of the Academy by another member appointed for that purpose.

RECENT soundings have given the following depths for the different Swiss lakes:—Constance, between Uttwyl and Friedrichshafen, 255 metres; Geneva, between Rivaz and Saint-Giugolphe, 256 metres; and between Lausanne and Evian, 330 metres; Brienne, 261; Thun, 217; Lucerne, between Gérau and Rueteren, 214 metres; Zug, 198; Neuchatel, 153; Wallenstadt, 151; and Zürich, 143 metres.

ACCORDING to Prof. Heim, of Zürich, the total number of glaciers in the Alps is 1155, of which 249 have a length of more than 7500 metres. Of this number the French Alps contain 144, those of Italy 78, of Switzerland 471, and of Austria 462. The total superficial area of these glaciers is between three and four thousand square kilometres, those of Switzerland amounting to 1839 kilometres. The greatest length is reached by the Aletsch glacier, which is 24 kilometres long. As to thickness, it will be remembered that Agassiz, when measuring a crevasse in the Aar glacier, did not reach the bottom at 260 metres, and that he calculated the depth of the bed of ice at a certain point of this glacier at 460 metres.

WE have received the *Bulletin* for the past year of the Society for Indo-Chinese Studies of Saigon. Amongst the papers is one by that indefatigable student, Dr. Tirant, on the odoriferous woods of Cochin China, which, though numerous in variety, are of four principal kinds, the most important being aloes and sandalwood. We have already noticed a series of papers by the same writer on the fishes and reptiles of Cochin China. Another interesting paper deals with the textile plant *Sanseviera* as found in Cochin China.

A COMMISSION composed of MM. Becquerie, Berger, and Mascart, having been appointed to examine the question of the